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PLANT ECOLOGY AND ITS RELATION TO AGRICULTURE[1]

I. CONTENT OF ECOLOGY

A. Nature and Scope.—In beginning this discussion, a brief statement as to the nature and scope of ecology seems to be desirable on account of the hazy popular notions on the subject. Outside of a rather narrow circle one usually finds a total ignorance of the meaning of the word itself, and even among biologists, some are familiar only with the observational side, due probably to the early prominence of the "car-window" school of ecologists, while others consider that the subject-matter of ecology might better be divided between morphology and physiology, and frankly state their opinion that there is no such subject as ecology.

However, there seems to be a mass of subject-matter belonging to neither department exclusively, but partly to each, which would fairly warrant the formation of another department. This has been named ecology, and may be defined as the science of organisms as affected by the factors of their environment. The connection with physiology is the closer of the two, and in fact, the two subjects overlap to a certain extent, but whether we call this overlapping segment ecological physiology or physiological ecology, the character of its subject-matter is sufficiently different to warrant a separate category and different treatment.

The methods of ecology have been, of course, largely descriptive, but they are also becoming increasingly quantitative, employing in many cases elaborate and deli-

[1] Delivered before the Illinois Academy of Science, February 23, 1917.

cate instruments. The work is pursued both in the field and in the laboratory, and under experimentally controlled conditions, as well as under natural. The great task of ecology and the purpose of its observation and experimentation lies in the interpretation of the phenomena and the deduction from these data of the general principles underlying the reaction of plants to their environmental factors.

B. Content of General Ecology. 1. *Autecology.*—This branch of ecology studies the plant as an individual, and is largely physiological in nature. It considers the general results of the relation of the plant to its environmental factors, as shown in the division of plants into great classes according to their reaction to each of the leading factors.

These reactions come under three heads: First, the reactions in the activity only of the plant, as the increase of activity under favorable conditions and its diminution and even stoppage under adverse conditions. This group really belongs under the head of physiology, but when considered in the field under natural conditions it may be regarded as within the scope of ecology. Second, the effects on plastic tissues or organs of the plant. These may also be produced experimentally and frequently have an important bearing on the economic value of cultures. Third, the effects on permanent structure and function of plant organs.

Whatever may be our belief as to the method by which variations are produced and fixed in plants, it is evident that structures correspond more or less to function and are conditioned directly or indirectly by the environment. A comparative study of plants in different habitats leads us to identify or construct from the imagination certain "normal" or original types of organs. We find also modifications of these types, which are either temporary, where the plant tissues are plastic; or permanent, constituting variations. In tracing the correspondence of these changes to environmental differences we look for and frequently think we find what may be called ecological causes.

Plants are classified according to these modifications, both plastic and permanent, on the basis of the factor which seems to be chiefly responsible for the change. Chief among these is the moisture relation, expressed in the more or less familiar division into hydrophytes or water lovers, xerophytes or dry-climate plants, and mesophytes inhabiting an intermediate habitat. A similar relation to light and temperature divides plants into sun-tolerant and shade-tolerant, heat-tolerant and cold-tolerant, groups. The relation to the chemical elements in the soil is not so marked as was once thought to be the case, yet we still hear such words as "calciphiles" and "calciphobes," and the terms probably represent to a certain extent a real situation. The best illustration of this is shown in a comparison of organs, especially leaves, of hydrophytic as compared with xerophytic and mesophytic plants. Here there seems to be a very distinct correspondence between structure and the markedly different environments of these different habitats.

2. *Synecology,* which studies plants in the mass, is largely concerned with distribution of plants, and may be regarded as an application of autecology in the grouping of plants within greater or smaller areas of the earth's surface. It may be divided into (*a*) "Phytogeography," in which the groupings are regional and the result of climatic factors, and (*b*) "Physiographic Ecology," in which the groupings are local, as the result of physiography with attendant climatic modifications. These groupings are called plant associations and the fact that different associations

follow each other successively is expressed in the term "Plant Succession."

C. Special Ecology of Structural Groups.—While all ecological groups have more or less specific reactions which are considered under their appropriate heads, there is one grouping which demands separate treatment because it is based on the most striking structural feature—the presence or absence of woody tissue, and also because of its practical relation to man's activities. Although verging more closely on agriculture, it may still be classed as ecology because the point of approach is from the side of the environmental relations. On the basis of woody structure we classify plants as trees and herbaceous plants with shrubs and lianas occupying an intermediate position, and it is at once evident that these two groups have decidedly different ecological reactions.

1. *Ecology of Trees and Shrubs.*—This study would involve (*a*) description of leading species with their habits of growth, characteristic structures, and ecological interpretation of the same. This would be the autecology of the group. (*b*) The synecology would involve the distribution and range of the leading species and their relation to ecological causes. (*c*) We might notice also the influence of the species on their environment as illustrated in the influence of forests on soil moisture content through their control of run-off; and the influence of individual trees, as for example, the eucalyptus in the reduction of soil water; also the influence of forests on soil in the formation of humus and the effect of trees on wind, as in protection by windbreaks. (*d*) It could include also a classification of trees according to the character of their wood, including distribution of the different woods and methods of utilizing. Also a similar classification according to the character of their fruits, their chemical products and their value for ornament.

2. *Ecology of Herbs.*—Here should be studied (*a*) the general characteristics of herbs as distinguishing them from trees, with the ecological differences involved, under the heads of shoot, root, flower and fruit, with the characteristic differences between perennials and annuals; (*b*) a study of herbs as classified according to their value to man, as: valueless or "wild," those of economic value or "cultivated," and those undesirable or injurious, which we call "weeds." Uncultivated herbs are of interest chiefly synecologically as the associates of trees in their different groupings and as indicators of the characteristics of the environment, as hydrophytic, xerophytic, etc. As the subject of taxonomy has to do chiefly with the wild herbs it is frequently included under ecology to-day.

Cultivated herbs and their attendant, though undesirable forms, are considered more from the autecological side. Their reactions to and tolerance of extremes of temperature and moisture and chemical conditions, are of course of chief importance. Original habitat and distribution and to some extent taxonomic relations, are also important as indicating suitability for certain environments. This value is testified to by the systematic search for new varieties carried on by the United States Department of Agriculture. Herbs vary greatly in their reactions to environmental factors, and should be grouped as far as possible along the lines of similar behavior. Knowledge of these groups should be as complete as possible, but a thorough study of the ecological reactions of a few type genera and species should be included in any comprehensive course in ecology.

3. The ecology of lower types of plants is not treated separately, but on account of

economic importance under the special subject of bacteriology, mycology, etc.

II. RELATION OF ECOLOGY TO AGRICULTURE

A. Purpose and Scope of Agriculture.—The subject of agriculture is extremely complex and even the terminology is not uniform in usage. Even the word agriculture itself is employed in a general and a special manner. It is used here in the general sense of the cultivation of plant products from the soil. Its complexity is made evident by consideration of the varied ends sought, which include size, strength, water content, and chemical contents of stem, leaves, roots, flowers, fruit and special parts such as fibers, cork, etc.

The resulting subdivisions of the subject following largely the usage of Bailey's "Cyclopedia of Horticulture," are: Agriculture (in its special sense), which includes the culture of grain, forage crops, bread stuffs, textiles, etc.; horticulture, which includes fruits, vegetables, flowers and ornamental plants; and forestry, which is the complete treatment of other trees, and includes subjects of sylviculture, mensuration and harvesting. Through all this complexity runs a general unity of purpose, namely, the preparing and maintaining of optimum conditions for the production of maximum returns. Therefore the processes and principles are in the main the same, being varied in practise for the different ends.

B. Agricultural Processes with their ecological significance.

1. The preparation of optimum conditions. The preparation of the soil is the first condition, but as the principles are the same as those in the preservation of optimum conditions it will be considered under that heading. The second important factor is the securing of suitable stock, either seed or vegetative, for which the criteria are the taxonomic relations and the reactions to the environment. The choosing of this stock is a question of balancing specific reactions of the desired plant with the factors of the necessary location, or vice versa. The securing of this stock is brought about either through breeding, by pollination, or by grafting; and by choice, through the testing of known varieties, the selecting of the results of breeding, or the discovery of new varieties. Of course through all these methods runs the question of reaction to the desired environment. A third ecological factor in preparation of conditions consists in the choice of a suitable time and location for the culture.

2. The preservation of optimum conditions. (*a*) The condition of first importance is the soil. In its moisture content the maintenance of optimum moisture conditions is of course extremely important. The maintenance of its physical condition is popularly called tillage. The chemical composition is shown by analysis and experiments with plants, and is modified by the use of fertilizers and of other chemicals. The temperature of the soil is less considered, but may be determined by the use of soil thermometers. (*b*) Optimum conditions of light, wind and temperature depend upon exposure, and may be controlled by modifications of this exposure. Light is studied by light intensity experiments and controlled by screening or by thinning. The effect of wind is shown largely by transpiration, measured by the atmometer, controlled by thinning or by windbreaks. Temperature is observed by the thermometer and controlled by shelters and by protective covering. (*c*) The importance of disease as a factor has been recognized by the great development of the subject of plant pathology.

3. The third agricultural process is the

harvesting of crops, in which ecology does not function very largely, except in so far as it may assist in the determining of the time of maximum returns.

C. Nature of Contributions of Ecology.—It is admitted by all, that agriculture is largely an art, and that its processes until rather recently were developed almost entirely by empirical methods. Evidences of this are still shown in many agricultural texts and farmers' bulletins, where processes are recommended because of success in certain localities or condemned because of failure.

As scientific knowledge and methods advanced, the agrieulturists began to take advantage of these methods and we find many agricultural practises based on truly scientific work. This is especially true of the agricultural chemists from the days of Liebig down, although their claim to the title agriculturalists in the ordinary sense of the word might be questioned by some.

It must be recognized that many of the methods of agriculture are still empirical, and in some cases necessarily so on account of the lack of equipment of the constituency, but it is admitted that the scientific are better where possible. Even in experiment station work, there is a danger present, through the tendency to accumulate masses of data with too little correlation and generalization. The purpose of experimentation is to determine causes and to draw general principles whose application will avoid the necessity of further experiments. Failure to generalize nullifies this purpose; in fact, unlimited experimentation is empiricism.

The methods of ecology are scientific, its materials are largely the same as those of agriculture and its practical applications are found chiefly in the field of agriculture. For these reasons it is evident that ecology belongs both to botany and to agriculture, and in fact covers the debatable ground between the two subjects. Instead of this being, as is too often the case under such circumstances, the cause of rivalry and even conflict, it should furnish a common ground for cooperation and both parties should endeavor to maintain a high standard in investigation and generalization of the condition of plant responses to environmental factors.

The services of ecology to agriculture then are twofold, first in the developing of the principles on which agricultural practices are to be based, and second in furnishing a comprehensive source of information for the handling of specific cases and the answering of specific questions of agricultural policy.

D. Illustrations from Definite Contributions of Ecology.—Atmospheric moisture is observed quantitatively by means of the atmometer, which may be used as a measure of plant transpiration. Recent results show a most remarkable detailed correspondence between the curve of an open-pan atmometer and that of a controlled plant of alfalfa. In soil moisture content the mechanical determining of the wilting coefficient by the centrifugal method is a valuable achievement, and is having an increasing application in the determining of the quantity of water to be applied in irrigation. The study of the extension of root systems is having an increasing influence in determining the relation of plants to the soil moisture content.

In light we have both the measure of the intensity of light by Wiesner and Clements, and recently the measurement of photolytic ability of light by a delicate apparatus devised by MacDougal. Under chemical content the recent work of Coville with blueberries is widely known on account of its publication in the *National Geographic Magazine*. One of the difficulties of this

quantitative work lies in the fact that the factors all work together on the plant, and measurement taken of individual factors may not indicate the true effect of the same factor working with others. Livingston's suggestion of using the living plant as an index is aimed at overcoming this difficulty.

Along physiographic lines, Cowles's recent work on so-called lakes of the Mississippi valley has applied the principles of plant succession in a very practical way. The control of moving sand is best accomplished by application of ecological principles in the choice of plants for that extremely xerophytic habitat.

E. Place of Ecology in an Agricultural Course of Study.—Up to the present the method in agricultural texts and courses has been to teach a little plant morphology, a chapter on plant activities, and then nine tenths of the work on agricultural practise. In addition to that we would recommend the insertion of a section on ecological principles, covering the content of ecology as outlined above. This should be general and theoretical, yet so related to agricultural practise as to form a suitable foundation for an agricultural course. A knowledge of these principles is fundamental to any real grasp of the subject.

In conclusion, emphasis should be laid on the fact that this discussion does not aim to criticize present agricultural activities, but to emphasize what is now being done along scientific lines for the development of the general principles underlying the practise of agriculture, and the importance of its extension as far as possible. Secondly, to point out the opportunities in this growing branch of science and to urge the teaching of some brief but comprehensive study of the principles of ecology in all agricultural courses.

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Evanston, Ill.

FISH NAMES, ANCIENT AND MODERN, AND EARLY ILLUSTRATIONS OF FISHES

A favorite topic which has engaged the attention of naturalists in all ages has been the identification of the names bestowed on plants and animals by ancient authors, particularly those of classical antiquity.

Probably no living naturalist has made more profound study of this subject than Professor D'Arcy Wentworth Thompson, of Dundee. whose "Glossary of Greek Birds" (1895) and new translation of Aristotle's "History of Animals" (1910) are monuments of patient industry and vast erudition, both philological and zoological. So able a critic as the late Dr. T. N. Gill has recorded[1] in glowing terms his appreciation of the merits of Professor Thompson's researches.

Dr Gill's own labors in the same field have illumined many an obscure point in the interpretation of ancient Greek and Roman writers on natural history. We may recall here an article of his in the *American Naturalist* for 1873 (vol. 7, pp. 458–463) "On the Status of Aristotle in Systematic Zoology"; also his address before the American Association in 1896 on "Some Questions on Nomenclature." His scientific papers and reviews fairly teem with discussions of fish etymologies, and his article on the Glanis of Aristotle is a fine presentation of the results of scholarly research.[2]

Dr. D. S. Jordan also, to mention only one other contemporary ichthyologist, has performed, in association with H. A. Hoffmann, a valuable service in investigating vernacular names, ancient and modern, as applied to the fishes of the Greek peninsula and archipelago. A joint paper by Jordan and Hoffmann, embodying a catalogue of the fishes of Greece, was published in the *Proceedings of the American Philosophical Society* for 1892.

Among ichthyologists of the last century, Georges Cuvier was probably at more pains than any other author to determine what species of fish were referred to under the appel-

[1] Science, Vol. 33, 1911, pp. 730–738.

[2] Bull. George Washington Univ., Vol. 5, 1906.

lations of early writers. After him A. Koraes (or Coray), Johannes Müller, Louis Agassiz, Erhard, Lowe, and the various editors and translators of Aristotle (Strack, Barthélemy, J. G. Meyer, Ogle, Aubert and Wimmer) and other ancient writers also rendered notable services. Other commentaries of value relating to the Greek fauna and its nomenclature were made during the last century by President Felton and Professor Sophocles of Harvard, and by several native Greek students, such as Nicolaos Christo Apostolides, D. Bikélas and Ioannos Bouros. The last-named was a professor at Athens, and published an essay in Greek of which an abstract appeared in Oken's Isis for 1841. Apostolides is author of a catalogue of the fishes of Greece and also of a list of the freshwater fishes of Thessaly.

Johannes Müller, in his elaborate memoir[3] "Ueber den glatten Hai des Aristotelis," devotes a separate section to the attempts of 16th century ichthyologists to identify the species of shark (*Galeus lævis*) referred to by the "father of natural history."

In point of fact nearly all of the 16th to 18th century writers on fishes—Belon, Rondelet, Salviani, Gesner, Willoughby, Aldrovandi, Artedi, Linnæus, Bloch and Schneider, together with lesser lights, and not forgetting Charles Estienne[4]—filled their works with copious references to and annotations on the numerous observations on fishes that have come down from classical antiquity. Among these "fathers of modern ichthyology" Aldrovandi is credited by Sundevall, in his introduction to the "Thierarten des Aristoteles," with having "fast alles gesammelt, was die Alten über die Thiere gesagt haben." But with respect to Aristotelian writings alone we cannot do better than quote Professor Thompson's remark, that "to annotate, illustrate, and criticize Aristotle's knowledge of natural history is a task without end."

It will thus be seen that there has been a steady succession of commentators upon the etymology of ancient fish names from the beginning of the modern science of ichthyology down to the present day; nor are commentaries wanting upon early patristic and mediæval authors who have left memorials of the knowledge of the times respecting natural history topics. Thus, there was published a score of years ago, by Hosius, an annotated edition of Decius Magnus Ausonius, a Roman consul of the 4th century whose idyll on the Moselle contains recognizable descriptions of sixteen species of fish. Modern editions have been published[5] also of Konrad von Megenberg's "Buch der Natur," written about the middle of the 14th century, a work which in itself is but a free rendering in the German vernacular of "De Natura Rerum," by Thomas of Cantimpre (b. 1201, d. 1272). A similar service has been performed by H. Stadler for the "Historia Animalium" of Albertus Magnus (b. 1193, d. 1280). As an illustration of Konrad's style of description the following extract may be quoted from his chapter on Fishes. It relates to the Remora or Echeneis:

> Echeneis haizt ain ech. Der visch ist halpfuezig, sam Jacobus und Isidorus sprechent, und ist sô kreftig, daz er ain schef stil helt, daz ez sich nindert wegt, ez slahen die wind in daz mer oder ez slahen die ünden, und wie sêr die wazzerflüzz diezzen, sô mag daz schef weder für sich noch hinder sich, reht als ob ez dâ gruntvest hab und dâ gewurzelt sei, niht dar umb, daz ez daz vischel wider ziehe, neur dar umb, daz daz vischel dar an hanget. Daz sprechent auch Ambrosius, Jacobus [*sic*] Aquinas, Aristotelis, Isidorus und der groz Basilius. Nu spricht Albertus . . . Plinius, Rabannus, Alex-

[3] *Abhandl. Akad. Wiss. Berlin,* 1840 (1842), pp. 187–258.

[4] Charles Estienne (Lat. Stephanus, b. 1504, d. 1564), a physician at Paris, was author of "La maison rustique," which passed through thirty editions. In 1537, and again in 1544 and 1546, he published a commentary on classical names of plants and animals entitled as follows: De Latinis et Græcis nominibus arborum, fruticum, herbarum, piscium et avium liber; ex Aristotele, Theophrasto, Dioscoride, Galeno, Nicandro, Athenæo, Oppiano, Æliano, Plinio, Hermolao Barbaro et Johanne Ruellio, cum gallica eorum nominum appellatione. Lutetiæ, 1544. 84 p. 8°.

[5] One by F. Pfeiffer in 1861, and another by H. Schulz in 1897.

ander, Solinus, Jeronymus, Augustinus, Adelinus, Haimo, Ambrosius, Maister Jorach.''[6]

Although Konrad von Megenberg's "Buch der Natur" has been properly recognized as the earliest natural history compendium in the German language, we must go back two centuries earlier before meeting the first German naturalist. This distinction belongs to the remarkable personage known as Saint Hildegard (in Latin Hildegarde de Pinguia, b. 1098, d. 1179), abbess of Bingen. Her original observations on natural history are contained in nine books called the "Physica," the first printed edition of which appeared in 1533, and the second in 1536. Book V. of this work, in 37 chapters, treats of fishes, and the descriptions of them are given in such terms that all of the species are identifiable.[7]

Concerning mediæval fish names it will be sufficient to refer to but two or three other publications, all by German philologists. One is an essay of 35 pages by Friedrich Schmidt, entitled "Die mittelenglische Version des Elucidarius des Honorius Augustodunensis," published in 1909. Another is J. J. Koehler's work of 87 pages devoted exclusively to old English fish names, published as Heft 21 of Anglistische Forschungen, Heidelberg, 1906. Lastly, mention should be made of Professor Karl Krumbacher's publication of "Das mittelgriechisches Fischbuch," a Byzantine work dating from about the twelfth century.

Returning to our own times, a long list might be given of articles dealing with the vernacular names of fishes in nearly all modern languages, including Chinese and Japanese. We will, however, content ourselves with citing but two useful works, the first of which contains a bibliography of 31 pages. These are, first, Émile Belloc, "Noms scientifiques et vulgaires des principaux poissons, etc.," Paris, 1899, 200 p. 8°. And second, P. P. C. Hoek, "Catalogue des poissons du Nord de l'Europe avec les noms vulgaires dont on se sert dans les langues de cette region" (Conseil Perm. Int. Explor. Mer, Pub. de Circonstance, no. 12, 1904).

EARLY PORTRAYALS OF FISHES

A special bibliography would be required to enumerate all of the articles that have been written on such subjects as prehistoric effigies of fishes, their representation in Egyptian monuments, ancient Greek vase paintings, Pompeian frescoes, the catacombs of Rome, and in the plastic and textile arts of pre-Columbian inhabitants of the western world. There is even a special group of articles dealing with the fish as a religious symbol in the early church, and with the fish motive in Christian art. But in the present note we wish to consider a more modern phase of fish portrayals.

Fishes and "sea-monsters" figured frequently in popular mediæval legends and bestiaries, and grotesque drawings of them were taken over into printed books from manuscript works which had been in circulation prior to the invention of printing. Among the various Herbals, or household recipe-books for medicines, which contained accounts of animals as well as plants and their uses in medicine, one that passed through numerous editions and translations was the "Hortus Sanitatis" of an author or compiler who styles himself Johannes von Cube. This soubriquet has been supposed by some to be a punning pseudonym for Dr. Johann Wonnecken, town physician of Frank-

[6] Concerning the last-named authority, "Jorach" or Jorath, little is known except that he was an eastern, perhaps Persian writer, whose work "De Animalibus" is quoted by the thirteenth century encyclopedists, Vincent de Beauvais, Albertus Magnus and Bartholomæus Anglicus. Bartholomew's encyclopedia, "On the Properties of Things," was written originally in Latin some years prior to 1260, and was translated into English by John Trevisa in 1397. An epitome of it, under the title of "Mediæval Lore," was published by Robert Steele in 1893.

[7] See in particular L. Geisenheyner, "Ueber die Physica der heiligen Hildegard von Bingen, etc." *Sitzber. Naturh. Ver. Preussen, Rheinlande u. Westfalens*, 1911 (1912), *E*, pp. 49–72. Also E. Wasmann, Hildegard von Bingen als älteste deutsche Naturforscherin. *Biol. Centralbl.*, Vol. 33, 1913, pp. 278–288.

fort. The "Hortus," or "Ortus," was first issued at Metz about 1475, and other editions appeared at Strasburg about 1590 and later. The part entitled "Tractatus de piscibus" is divided into many short chapters, and has numerous woodcuts of fish and fishing, all of very singular character.

Those who are familiar with ancient angling literature will recall in this connection the earliest known book on fowling and fishing, written in Flemish and printed at Antwerp in 1492. It is usually referred to as the "Boecxken," or in German as "Buechlin" or "Fischbuchlin" (editions of 1552 and 1578), and contains woodcuts of angling scenes. As a treatise on fishing, this tract has priority in date over "The Book of St. Albans," ascribed to Dame Juliana Barnes, Bernes or Berners. The first edition of this work was printed by the school-master printer of St. Albans in 1486, but did not contain the "Treatyse of fysshynge wyth an angle" with its accompanying woodcut. The second edition, from the press of Wynkyn de Worde at Westminster in 1496, does contain it, however, and it appears also to have been published as a "lytyll plaunflet" in London about 1500. There are excellent modern facsimile editions of both the "Book of St. Albans" (M. G. Watkins, 1880) and the early Flemish tract known as "Boecxken" (Alfred Denison, 1872). A still earlier facsimile edition of Dame Barnes' book is that by Mr. Joseph Haslewood, in 1810; and in 1816 the same bibliographer brought out the second English edition of "The Dialogues of Creatures Moralysed." The edition was limited to 100 copies, and of these 56 were destroyed by fire. A Dutch version was printed in 1480, and a French in 1482, both of them containing illustrations of fish and fishing scenes.

Modern reproductions have also been published of the remarkably fine animal drawings in the "Album de Villard de Honnecourt" (Lassus, 1858), dating from the thirteenth century in France, and in "Das Tierbuch des Petrus Candidus, geschrieben 1460" (Killermann, 1914). It is to be hoped that before very long we may have at our disposal facsimile reprints of the wonderful animal figures, including fishes, which embellish four valuable codices preserved in the Landesbibliothek at Stuttgart. Two of these manuscripts happen to be translations of the "Liber de Natura Rerum," by Thomas of Cantimpré, who spent fifteen years in its preparation prior to 1240. Strangely enough, although translations of this work have been published (one of them by Konrad von Megenberg, noticed above), the original text has never been printed. Large portions of it were, however, incorporated by Vincent de Beauvais in his various works, especially his the "Speculum Naturale." Besides the Stuttgart codex of Thomas Cantipratensis, others are preserved in the libraries of Paris and Cracow. In Book VII., the author treats of freshwater and marine fishes.

For the benefit of those interested in the history of early prints and book illustrations we may refer finally to the recently published "List of works in the New York Public Library relating to prints and their production," compiled by F. Weitenkampf (1915), and also to Dr. Ludwig Choulant's articles on illustrated incunabula relating to natural history and medicine.

C. R. EASTMAN
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

SCIENTIFIC EVENTS

CALIFORNIA PETROLEUM

WITHIN a few days there will be issued the Report of the Committee on Petroleum of the California State Council of Defense. The members of the Committee on Petroleum are:

Max Thelen, president California Railroad Commission, chairman,
Eliot Blackwelder, professor of geology, University of Illinois,
David M. Folsom, professor of mining, Stanford University.

The committee was appointed by Governor Wm. D. Stephens on May 9, 1917, for the purpose of ascertaining and reporting to him the facts with reference to the production, distribution and utilization of California petroleum and its products. The report has been ap-

proved by Governor Stephens and has been forwarded by him to President Wilson with an urgent plea for action by the federal government to solve California's and the nation's petroleum problem.

The report consists of 12 chapters, as follows:

Chapter I. Letter of Transmittal.
Chapter II. World Petroleum Situation.
Chapter III. California Petroleum Fields.
Chapter IV. Production of California Petroleum.
Chapter V. Storage of California Petroleum.
Chapter VI. Transportation of California Petroleum.
Chapter VII. Refining of California Petroleum.
Chapter VIII. Utilization of California Petroleum.
Chapter IX. General Review—Production and Consumption.
Chapter X. Production—Maintenance and Increase.
Chapter XI. Conservation.
Chapter XII. Conclusions and Recommendations.

Chapter XII. contains the committee's conclusions and recommendations, and the two preceding chapters deal with the possibilities, respectively, of increasing the supply and of decreasing the consumption of California petroleum and its products.

THE STATES RELATIONS SERVICE AND AGRICULTURAL INSTRUCTION

Resolutions were passed at a conference in Washington on May 5, 1917, by representatives of the National Association of State Universities, the Association of American Agricultural Colleges and Experiment Stations, the Association of American Universities, the Association of American Colleges, and the institutional committee of the Society for the Promotion of Engineering Education, requesting the advisory commission to recommend to the Council of National Defense that it approve the plan of developing and issuing at once through the States Relations Service of the U. S. Department of Agriculture a statement of a comprehensive policy of cooperation between the government and the universities, colleges and other schools which will make for the most effective use of these institutions along agricultural lines throughout the duration of the war. In order to carry out this program the States Relations Service has appointed the following committee:

Professor G. A. Works, Cornell University.
Mr. L. H. Dennis, director of vocational agricultural instruction.
Professor H. F. Cotterman, Maryland State College of Agriculture.
Dr. C. H. Winkler, University of West Virginia.
Professor F. B. Jenks, University of Vermont, secretary.
Mr. C. H. Lane, States Relations Service, chairman.

The States Relations Service will bring this committee together in Washington from time to time, as may seem expedient, with the committee on education of the advisory commission for the consideration of the best methods of maintaining, adjusting and strengthening the agricultural instruction of the country in order to meet the emergencies of the war and to plan for the period following the war.

MEDICAL STUDENTS AND THE DRAFT

The Provost Marshall General has sent the following to governors of all states:

The President prescribes the following supplemental regulations governing the execution of the selective-service law.

First. Hospital internes who are graduates of well-recognized medical schools or medical students in their fourth, third, or second year in any well-recognized medical school who have not been called by a local board may enlist in the Enlisted Reserve Corps provided for by section 55 of the national defense act under regulations to be issued by the Surgeon General, and if they are thereafter called by a local board they may be discharged on proper claim presented on the ground that they are in the military service of the United States.

Second. A hospital interne who is a graduate of a well-recognized medical school or a medical student in his fourth, third, or second year in any well-recognized medical school, who has been called by a local board and physically examined and accepted and by or in behalf of whom no claim for exemption or discharge is pending, and who has not been ordered to military duty, may apply to the Surgeon General of the Army to be ordered to

report at once to a local board for military duty and thus be inducted into the military service of the United States, immediately thereupon to be discharged from the National Army for the purpose of enlisting in the Enlisted Reserve Corps of the Medical Department. With every such request must be inclosed a copy of the order of the local board calling him to report for physical examination (Form 103), affidavit evidence of the status of the applicant as a medical student or interne and an engagement to enlist in the Enlisted Reserve Corps of the Medical Department.

Upon receipt of such application with the named inclosures the Surgeon General will forward the case to the Adjutant General with his recommendations. Thereupon the Adjutant General may issue an order to such interne or medical student to report to his local board for military duty on a specified date, in person or by mail or telegraph, as seems most desirable. This order may issue regardless of the person's order of liability for military service. From and after the date so specified such person shall be in the military service of the United States. He shall not be sent by the local board to a mobilization camp, but shall remain awaiting the orders of the Adjutant General of the Army. The Adjutant General may forthwith issue an order discharging such person from the military service for the convenience of the government.

Three official copies of the discharge order should be sent at once by the Adjutant General to the local board. Upon receipt of these orders the local board should enter the name of the man discharged on Form 164A and forward Form 164A, together with two of the certified copies of the order of discharge, to the mobilization camp to which it furnishes men. The authorities at the mobilization camp will make the necessary entries to complete Form 164A, and will thereupon give the local board credit on its net quota for one drafted man.

SCIENTIFIC MEN AND NATIONAL SERVICE

ON August 15, the Editor of SCIENCE addressed the following letter to the Surgeon General of the Army:

I shall be under obligations to you if you are able to tell me what steps are being taken to make use in the medical service of the army of men who are conscripted who are not physicians but have scientific training that would enable them to render greater national service than by serving in the regular army. If you are willing to make a statement that could be printed in SCIENCE, it would assist many scientific men who are at present doubtful as to what they should do.

The following reply, dated August 29, has been received:

In reply to your communication of August 15 requesting information relating to drafted men who possess scientific training, I beg to advise you that the Sanitary Corps of the United States Army, attached to the Medical Department, will accept a number of selected men who are not physicians but who have attained professional standing in bacteriology, chemistry and the several branches of engineering pertaining to sanitation. The Corps was organized specially to secure the services of skilled sanitarians having experience in both practical field work as well as those specially qualified in the several scientific branches having a correlation to the sanitary sciences.

By order of the Surgeon General:

C. L. FURBUSH,
Major, Medical Reserve Corps,
United States Army

SCIENTIFIC NOTES AND NEWS

PROFESSOR THEODORE LYMAN, of the department of physics at Harvard University, has received from the War Department a commission as captain in the aviation department of the United States Signal Corps, and has been ordered to report for active service in France. Profesor Lyman has been since 1910 director of the Jefferson Physical Laboratory at Harvard.

PROFESSOR H. GIDEON WELLS, of the department of pathology of the University of Chicago, and head of the Otho S. A. Sprague Memorial Institute, has been appointed a member of the commission on behalf of the American Red Cross to go to Roumania for the purpose of investigating the conditions there and planning for Red Cross assistance in that field. He has been granted leave of absence by the trustees until January, 1918.

Professor Basil C. H. Harvey, of the department of anatomy of the University of Chicago, who has been appointed to the Medical Department of the United States Army, with the rank of captain, has been granted one year's leave of absence by the board of trustees. Assistant Professor Norman MacLeod Harris, of the department of hygiene and bacteriology, who has been serving abroad in the Canadian Medical Corps for the past year, has had his leave of absence extended for another year.

Professor Alfred Atkinson, of the department of agronomy, at the Montana State College, has been appointed by Mr. Herbert C. Hoover food commissioner of the state of Montana.

Professor Herbert W. Mumford, of the University of Illinois, is now associated with the Bureau of Markets of the United States Department of Agriculture as consulting specialist in live-stock marketing.

Dr. A. C. Trowbridge, of the department of geology of the Iowa State University, has been made director of the Y. M. C. A.'s educational work at the Des Moines cantonment.

Robert A. Hall, Ph.D. (Chicago), formerly assistant professor in physiological chemistry at the University of Minnesota, has been appointed to a lieutenancy in the army and is now on his way to France for immediate service.

Dr. Bennet M. Allen, professor of zoology in the University of Kansas, recently delivered an address on "Experiments upon the glands of internal secretion in amphibian larvæ" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

Dr. Alonzo E. Taylor, of the University of Pennsylvania, member of the advisory board of food division of the surgeon-general's office, will visit the several medical officers' training camps and deliver a series of lectures on food values, food needs, and preparation and conservation of food.

The board of regents of the University of Michigan have approved a plan of Professor Henderson, director of the extension service, for the giving of about fifty extension lectures before the troops to be gathered at the Battle Creek Cantonment. These lectures are to be given by members of the faculty without compensation, and with the reimbursement by the university to them of their actual traveling and hotel expenses, for which the university extension fund already provides.

The Paris Academy of Sciences has received a gift from Mme. Beauregard to found a memorial to M. Clément Félix, the well-known electrical engineer.

Dr. C. O. Trechmann, of Hartlepool, England, who, while engaged in the manufacture of Portland cement, made contributions to mineralogy, crystallography and entomology, died on June 29.

George Wilber Hartwell, professor of mathematics and registrar in Hamline University, St. Paul, died on July 23 of appendicitis. Dr. Hartwell was born in New Jersey in 1881 and was graduated from Wesleyan University in 1903. After two years spent in teaching in the Michigan Agricultural College, he went to Columbia University on a fellowship, and there took the Ph.D degree in 1908. After filling a one-year vacancy in the University of Kansas, where he was elected to Sigma XI, he went to Hamline University as professor. The year following he became registrar, and continued in these positions until his death. He was a member of the American Mathematical Society and several similar foreign societies. The correspondent who sends us this information writes that Dr. Hartwell was not only a scholar of brilliant powers, but he was an executive officer of such tact and ability and a man of such decision and force that his loss to the college and his associates can hardly be estimated.

At Liverpool University an advisory committee of ten members has been formed in order to develop the chemical industry after the war; it consists of four members of the chemical staff of the university and six others representing the chemical industries.

The annual meeting of the American Public Health Association, which was to have been held in New Orleans in December, will be held

in Washington by direction of the executive committee. War hygiene will be the central theme of discussion, and Washington is the city where information regarding the sanitary problems of armies is being concentrated.

THE installation of a new aquarium at Woods Hole Station of the Bureau of Fisheries was completed on July 5, under the direction of Superintendent Harron, of the central station. The aquarium consists of 10 tanks, which are arranged along the western and northern sides of the exhibition room of the hatchery building. The old grotto is entirely displaced. The front of the aquarium is stained to represent Spanish oak. The interiors of the tanks are decorated with beach rocks of various sizes secured in the vicinity. The tanks were those used at the San Francisco exposition for the bureau's exhibit, but it was necessary to alter them in order to adapt them to the space allotted at Woods Hole. The aquarium makes a very pleasing exhibit and will be appreciated by the thousands of people who annually visit the station, in addition to serving a useful purpose in the scientific and fish-cultural work.

DR. MACNAMARA, a member for North Camberwell, in answering a question put in the British House of Commons, defined the functions of the Board of Invention and Research as follows: (*a*) To concentrate expert scientific inquiry on certain definite problems, the solution of which is of importance to the naval service; (*b*) to encourage research in directions in which it is probable that results of value to the navy may be obtained by organized scientific effort; (*c*) to consider schemes or suggestions put forward by inventors and other members of the general public. The board considers all inventions relating to naval warfare and acts in an advisory capacity to the Admirality. It has funds at its disposal for carrying out trials and experiments and possesses full facilities for arriving at a decision whether an invention is worthy of adoption or not; but the adoption of an invention is subject to the approval of the Board of Admiralty. The general superintendence of the Board of Invention and Research is reserved to the First Lord, to whom it has direct access. The Central Committee meets once a week; the panel once every six weeks, and the subcommittees hold meetings at frequent intervals as the circumstances require. The president has attended 54 sittings during the last 12 months. Dr. MacNamara also stated that the members of the board who received remuneration for their services were the president, £1,350 a year, in addition to retired pay; Vice-admiral Sir Richard H. Peirse (naval member of Central Committee), £1,530 a year; Professor W. H. Bragg (member of Panel), whilst occupying the post of resident director of research at an Admiralty experiment station, professorial salary of £1,000 a year at the University of London is refunded by the Admiralty to the university authorities; Dr. Dugald Clerk (member of Panel), as director of engineering research at the Admiralty Engineering Laboratory, City and Guilds (Engineering) College, South Kensington, is entitled to repayment of out-of-pocket expenses to an amount not exceeding £600 a year.

WE learn from the *Journal of Industrial and Engineering Chemistry* that through a cooperative agreement with Cornell University, representatives of the Bureau of Mines have been stationed at Morse Hall, where the electric furnace equipment of the department of chemistry has been utilized in some metallurgical work of the bureau. Experiments on the electric melting of brass have indicated that a suitable electric furnace might materially reduce the metal losses from volatilization and avoid the use of costly crucibles. The bureau is now testing a commercial-size furnace with special attention to its suitability for use on brasses for cartridges and shrapnel cases. Another electric furnace problem studied by the bureau has been the production of ferro-uranium from the uranium oxide obtained as a by-product in the extraction of radium from its ores. Ferro-uranium is used in making uranium steel, which is said to be used by Germany for the lining of big guns which will stand up at a rate of fire so rapid that other steels fail. It is undecided whether the work

on gun steel will be done at Cornell or some other university.

It is reported in *Nature* that in order to promote the further development of the dye-making industry in the United Kingdom, the president of the Board of Trade has decided to establish a special temporary department of the board to deal with matters relating to the encouragement, organization, and, so far as necessary, the regulation of that industry. The department will be under the direction of Sir Evan Jones, Bart., who has placed his services at the disposal of the president, and will have the official title of commissioner for dyes. The commissioner will act in close consultation with the various dye-making and dye-using interests concerned.

The United States Geological Survey, Department of the Interior, has issued as Bulletin 645 its "Bibliography of North American Geology for 1915," by J. M. Nickles. This bulletin is a list of the books, papers and maps bearing on the geology (including the paleontology, petrology and mineralogy) of North America and adjacent islands, and of Panama and Hawaii, issued in 1915. The papers are arranged alphabetically by names of authors and the bulletin contains a full alphabetical subject index by which any paper relating to any particular subject or area may be readily found. This bibliography is one of a series, the volume for 1911 forming Bulletin 524, that for 1912 Bulletin 545, that for 1913 Bulletin 584 and that for 1914 Bulletin 617. From time to time these bibliographies are combined in a single volume covering several years. The series now covers the literature of American geology from 1732 to the end of 1915.

The annual report on the Science Museum, and on the Geological Survey of Great Britain and Museum of Practical Geology, has been published as a White Paper for the Board of Education. According to an abstract in the London *Times* both museums have been closed to the public since March 6, 1916, but the scientific work has been continued so far as was possible under present conditions. The Science Museum remained open to students and for special purposes, the daily average of visitors after March being 132, as against 986 formerly. To the horology section Mr. Evan Roberts contributed over 200 watches and watch movements, of much historical and technical interest. The library of the London Mathematical Society was transferred and deposited on loan in the Science Library, and is being catalogued. The number of readers was 6,832, of whom two thirds were science teachers or students of the various colleges. The Geological Survey has also suffered from the war, which in turn has made special demands on the staff. Consultations and correspondence relating to military establishments at home and abroad have been frequent. Progress has been made with the "Series of special reports on the mineral resources of Great Britain," and with the standardizing of six-inch maps. The petrographical department has helped the Admiralty in the matter of aeroplane compasses, and the photographic work included the copying of maps and diagrams for military purposes and the making of microphotographs for the Admiralty. The Museum of Practical Geology was visited by 7,227 persons between January 1 and March 6, when it was closed to the public except for special inquiries. Donations during the year include a series of specimens, mainly rocks, from the western front, and igneous rocks from Imbros and Lemnos.

The Research Defense Society of Great Britain, owing to the continuance of the war, has again decided to postpone its annual general meeting. The committee's report of the work of the society during the past two years, as reported in *The British Medical Journal*, states that the inaction of the opponents of research had necessarily made the society less active. There had hardly been any controversy in the newspapers, and all through the country the great advances made in protective medicine due to research were being appreciated and better understood. The lectures given had been concerned more with the general influence of scientific medicine on the health and efficiency of the army than with experiments on animals. The Association for the Advancement of Medicine by Research decided last year in favor of amalgamation with the Re-

search Defense Society, and the president and honorary treasurer of the association, Sir Thomas Barlow and Dr. Hale White, have joined the committee of the society. It is hoped that in the coming years there will hardly be any need for disputes with antivivisection societies, and that the society's best opportunities for usefulness will be found in wide, non-aggressive educational work.

WE learn from *Nature* that the pensions granted during the past year by the British government include the following: Mrs. Charlton Bastian, in consideration of the services to science of her late husband, Dr. Charlton Bastian, and of her straitened circumstances, £100; Mrs. Minchin, in consideration of the scientific work of her late husband, Professor E. A. Minchin, and of her straitened circumstances, £75; Mrs. Albert Günther, in consideration of the scientific work of her late husband, Dr. Albert Günther, and of his distinguished services to the British Museum as keeper of zoology, £70; and Mrs. Roland Trimen, in consideration of the eminent services of her late husband to biological science, and of her straitened circumstances, £75.

UNIVERSITY AND EDUCATIONAL NEWS

THE will of Mrs. Robert W. Bingham, wife of Judge Robert Bingham, of Louisville, Ky., a graduate of the University of North Carolina, gives to the University of North Carolina $75,000 a year for the establishment of professorships and ultimately a capital sum producing this amount. The professorships are to be known as Kenan professorships, in memoriam of Mrs. Bingham's father, William R. Kenan, and her uncles, Thomas S. Kenan and James Graham Kenan, graduates of the university. The value of this bequest to the University of North Carolina is more than a million and a half dollars.

FRANCIS A. THOMSON has resigned from the faculty of the State College of Washington to accept the deanship of the school of mines at the University of Idaho, Moscow, Idaho.

DR. WALLACE BUTTRICK, member of the executive committee of the Rockefeller Foundation and director of its China Medical Board, is in England on the invitation of a department of the British government to confer with educators and officials in Great Britain concerning public education.

AT the University of Chicago the following promotions from associate professorships to professorships have been made: Basil C. H. Harvey, of the department of anatomy; Horatio Hackett Newman, of the department of zoology; J. Paul Goode, of the department of geography; Walter Sheldon Tower, of the department of geography. From an assistant professorship to an associate professorship: Arthur C. Lunn, of the department of mathematics.

AT the New Hampshire College A. W. Richardson, of the University of Maine, has been appointed assistant professor in charge of the poultry department to succeed R. V. Mitchell, and G. A. Minges, of Iowa State College, has been appointed instructor in chemistry. The chemistry department has lost two members owing to the war: Professor G. A. Perley has been granted leave of absence for the period of the war and is serving as first lieutenant in the division of chemical engineering, U. S. Army, and Arnold J. Grant has gone to the second Plattsburg Camp.

DISCUSSION AND CORRESPONDENCE

THE PUBLICATION OF SCIENTIFIC RESEARCH

TO THE EDITOR OF SCIENCE: A matter in which there is a considerable divergence between the practise of different laboratories is that of the method of publication of their results. A number of laboratories publish their own bulletins, either as separate papers or as periodical volumes. Others publish in the scientific and technical press, either in one or two journals or in a number of different journals according to the subjects dealt with.

Naturally, the best method of publication will depend to some extent on the nature of the work published and the character of the laboratory. In the case of a purely technical laboratory publishing a large number of papers dealing with one special, technical subject,

the method of publishing separate bulletins mailed directly to a selected list of those interested may be quite satisfactory, but if the publications of a laboratory cover a large range of subjects it would seem to be preferable to publish each paper in the journal which deals with the department of science most akin to that of the subject dealt with. If this is not done, there is a grave danger that the paper may be missed by the abstract journals and may fall out of sight altogether, while in any case the publication of single bulletins throws a heavy burden on any investigator engaged in compiling a bibliography of a subject.

In this laboratory we have confined the publication of our scientific communications to the recognized technical and scientific journals, and I find that our first fifty communications have been published in no less than seventeen different journals, twenty-eight being published in journals relating to some branch of physics, five in chemical journals, and seventeen in photographic publications.

Since it is an advantage for all the papers issued from one laboratory, which, naturally, have a common interest, to be available in some collected form, we issue periodically bulletins containing abridgments of all our scientific papers, the second volume of these bulletins containing the papers published during 1915 and 1916 being now ready.

It would be of interest to learn the views of others interested in this question as to the relative advantages of the issue of separate bulletins as compared with publication in the current press.

C. E. K. Mees

Research Laboratory,
Eastman Kodak Company

POPULAR SCIENCE

Unwarranted deductions have been drawn in a recent popularization of science by one of our eminent paleontologists, Dr. H. F. Osborn, not however in his own field, but in a special field apparently unfamiliar to him. Lest others may be misled into thinking that the deductions are based on good evidence, may I be permitted space to call attention to them.

Dr. C. D. Walcott has recently reported[1] the discovery in an Algonkian limestone of fossils having appearances and associations which give valid reasons, though not positive proof, for thinking them to be bacteria. The finding of these fossils in a limestone rock in association with fossil algæ as well as other related facts lends support to his previous suggestion[2] that this limestone was probably partially deposited by bacterial action in a manner similar to that described by G. H. Drew[3] as taking place to-day in the tropical waters about the Bahamas. A reference back to the article by Drew shows that the bacterium which he found causing the deposition of $CaCO_3$ is a denitrifier which he has named *Bacterium calcis*. It is an organism similar to other denitrifiers, possessing the power to reduce nitrates to nitrites with the later disappearance of the nitrite accompanied by the formation of ammonia and a gas which, from the few simple tests made, was in all probability free nitrogen. Like other denitrifiers, this organism was found to possess the power of utilizing organic carbon in the form of sugars and even possessed the power of secreting ectoenzymes capable of liquefying organic nitrogen compounds like gelatin. The precipitation of the calcium carbonate is explained as due to the increase in the concentration of CO_3 ions caused by the advent of $(NH_4)_2CO_3$, which is partially ionized into NH_4 and CO_3 ions.

If the validity of the evidence that the fossils found are bacterial in nature is admitted, and it is assumed that the particular fossils in question are of the organisms which were instrumental in having caused the deposit of limestone, then the deduction might be drawn that these fossils are those of denitrifying bacteria. The fact that Dr. Walcott refrained from making this deduction is quite probably due to the fact that he had a feeling that it would be based on too many "ifs."

Turning now to the article by Dr. Osborn[4]

[1] *Proc. Nat. Acad. Sci.*, 1: 256–257, 1915.

[2] *Smiths. Misc. Coll.*, 64: 76–156, 1914.

[3] Papers from Tortugas Lab., 5: 8–45, 1914, Pub. 182, Carn. Inst. Wash.

[4] *Sci. Monthly*, 3: 289–307, 1916.

we find that he has not been as cautious and that he sees in Dr. Walcott's fossil bacteria certain resemblances in appearance and structure to nitrogen-fixing bacteria from soil (by context the bacteria referred to appear to be *Azotobacter* and related forms). He is not dismayed by the fact that the metabolism of marine, denitrifying, lime-depositing bacteria, and that of the nitrogen-fixing bacteria in soil which utilize both atmospheric nitrogen and organic carbon, are in a sense opposed to each other. Still less is he troubled by the very great difference between the metabolism of nitrogen-fixing bacteria and the autotrophic, nitrifying bacteria like *Nitrosococcus* and *Nitrosomonas* organisms which do not utilize organic food and derive their nitrogen from ammonium salts instead of free nitrogen). In fact, he apparently thinks of the nitrifying and the nitrogen-fixing bacteria as essentially identical, as appears in the following statement (p. 292):

> The great antiquity of even higher forms of bacteria feeding on atmospheric nitrogen is proved by the discovery, announced by Walcott in 1915, of a species of pre-Paleozoic fossil bacteria attributed to "*Micrococcus*" but probably related rather to the existing *Nitrosococcus* which derives its nitrogen from ammonium salts.

The illogical nature of this statement may be brought out by substituting groups more familiar to paleontologists than are bacteria. Thus we have:

> The great antiquity of Carnivores feeding on flesh is proved by the discovery of a species of pre-Paleozoic mammal attributed to Herbivores, but probably related rather to Rodents who derive their food largely from grain and nuts.

Needless to say that Dr. Osborn would be the first to see the weakness in such a statement. In reality this paraphrase does not exaggerate the illogical nature of the original statement, though it may appear to do so to the layman unfamiliar with the fact that great differences in these tiny organisms are very frequently hidden behind superficial resemblences in appearance.

The almost universal uniformity in protoplasmic structure of living species of bacteria and their universal possession of a definite membrane which gives them definite form will cause bacteriologists to wonder at the statements on the following page of Dr. Osborn's article where he says:

> The cell structure of the Algonkian and of the recent *Nitrosococcus* bacteria is very primitive and uniform in appearance, the protoplasm being naked or unprotected.

Any one who looks at the uniform black of the fossil organisms in the microphotographs given and who realizes that these are pictures of fossils and not of living organisms will be skeptical in regard to the evidence on which this statement is based.

Statements based on evidence of the sort furnished which claim that the presence in the Algonkian of nitrifying, denitrifying or nitrogen-fixing bacteria has been shown appear like a pyramid of speculation supported on an apex of fact. They have, however, already misled a bacteriologist into an acceptance of one of these claims, for I. J. Kligler[5] says in a recent paper (p. 166):

> Finally Walcott's discovery of bacteria closely resembling our nitrogen fixers of the soil is added proof of the primitiveness of these microbes.

It is because of the great interest of the findings by Drew and Walcott, that this word of warning has been uttered to protect science from conclusions which others have drawn from them. If this is not done there is danger that the next time reference is made to their work it will be in some textbook as a positive statement that nitrifying, denitrifying or nitrogen-fixing bacteria, or all three, have been shown to exist as far back as the Algonkian.

R. S. BREED

N. Y. AGRICULTURAL EXPERIMENT STATION,
GENEVA, N. Y.

MAN AND THE ANTHROPOID

TO THE EDITOR OF SCIENCE: In the July 27 number of SCIENCE Prof. Mattoon M. Curtis devotes a column and a half to a criticism of the "common error" that man is a lineal descendant of the anthropoid apes. "The evident implication," he tells us, "is that the

[5] *Jour. Bact.*, 165–176, 1917.

extant anthropoids, orang, gibbon, gorilla and chimpanzee are intended." He proceeds to cite Duckworth to prove that this is an error, and concludes, so far as one can judge of his meaning, that man and the anthropoids are "not genetically related"—an amazing *non sequitur*.

One may parallel his argument in some such form as this: The existing Nordic peoples are currently asserted to be descendants of primitive races of man. The evident implication is that the extant primitive races, negroes, Australians, Red Indians, and Polynesians are intended. But Professor Ripley has recently shown that none of these races, constituted as they now are, figured in the ancestral history of the Nordic race. This may relieve our anxieties lest we might be descended from savages. While we do not know as much about such creatures as we might, it is perfectly clear that there is nothing to the absurd tradition that we Nordics are descended from them or they from us. It appears to be a sound principle that groups showing inverse developments are not genetically related, and it is well known that the Nordics are unusually light-colored while the savage races are remarkably dark; that the high and straight nose of the Nordic and his blue eyes are not to be found in these so-called inferior races of mankind; while most of them display thick lips which do not appear in the Nordic race.

And so on—but this surely is a sufficient *reductio ad absurdum*. Who believes that the human race is descended from the *existing* anthropoid apes? Who ever did that knew anything about it? How could it be so? How could prehistoric human beings be descended from anthropoids still living, unless, like Rider Haggard's "She," they were endowed with eternal life to outlive their descendants? Surely the writer can not but know that the current assertion means and can mean only that man is descended from the same ancestral stock as the anthropoid apes. What that ancestral stock was like, and how far and in what directions its living descendants have departed from it, is the problem which the "scientists" (whom he puts in "quotes" apparently intended in some obscure derogatory sense) are trying to find out, by the inferential evidence of anatomy, physiology, and kindred sciences, and by the direct but as yet scanty evidence of paleontology and archeology.

The final paragraph opens with a curious sentence which I quote:

> Whether "scientists" are entitled to believe what they please or are to be guided by observations and verifications is perhaps an open question.

Possibly I am mistaken and Mr. Curtis means by "scientists" the followers of Mrs. Eddy. I don't know their principles very well, but very possibly they do consider themselves entitled to "believe what they please" irrespective of evidence other than the assertions of "Science and Health." But surely no scientific man—without quotes—thinks himself entitled to believe anything regarding science save upon the evidence of observations and conclusions made and verified by himself and others. Nor does anybody else. The attitude is not peculiar to science. It is the ordinary man's attitude towards the common world about us; and science has no other attitude than that.

It is difficult to see in this letter anything save an attempt to discredit theories which the writer, without knowing much about them, does not wish to believe. I can hardly suppose that many readers of Science will take the argument seriously, in spite of a not inconsiderable dialectic skill. But however appropriate in some theological journal it appears somewhat in the category of "eccentric literature" in its present surroundings.

W. D. Matthew

SCIENTIFIC BOOKS

Bibliography of William Henry Welch, M.D., LL.D., 1875–1917. Prepared by Walter C. Burket, M.D., with foreword by Henry M. Hurd, M.D. Baltimore, The Johns Hopkins Press. 47 pp. 4°.

This is a notable contribution to medical bibliography, in the special sense of the term,

which implies an exhaustive and accurate index of all the books and periodical papers under a given subject or author, as distinguished from the bibliophilic sense, in which a book, incunabula or manuscript is described, like an object in natural history, in such a complete and unmistakable manner that its identification is always possible from the description. The scattered scientific papers and the varied public activities of Professor Welch are here set forth, for the first time, in a strict chronological order, which will be most useful to future medical historians and biographers. No one, for instance, could gain any just conception of the versatile and genial scientific work of Virchow or Weir Mitchell who has not gone over the "Virchow-Bibliographie" of 1901 or the catalogue which Mitchell himself prepared in 1894. As much of the best scientific literature of medicine is buried in the endless files of medical periodicals, medical bibliography, as standardized by Billings and Fletcher, enjoys the status of firearms in the early days of the far West—"sadly missed when badly wanted." The Welch bibliography, as Dr. Hurd tells us in the preface, has required the investigation of years, and is now printed because the interruptions of the present war have prevented the publication of the collective writings. In the first half of Dr. Burket's list (1875–1900), we find the larger scientific contributions of Welch, the great laboratory physician, his early investigations of the pathology of pulmonary œdema (1875), glomerulonephritis (1886), the structure of white thrombi (1887), his Cartwright lectures on the pathology of fever (1888), his discoveries of the staphylococcus which infects the edges of wounds (1891), and (with Nuttall) of the bacillus aerogenes capsulatus (1892), now of immense moment in Europe as the cause of gas infection in gunshot wounds, his synthesis of the many nondescript diseases caused by this bacillus (1900), his experiments (with Flexner) on the effects of injection of diphtheritic toxins (1891–2) and his monographs on thrombosis and embolism (1899). In his later period, Welch has been content to see his pupils carry out investigations inspired by him, so that the latter half of the bibliography, while replete with contributions on purely medical themes, is characterized by those addresses on public occasions in which Welch always acquits himself with the grace and charm of some distingué French academician.

As one who has had latterly to devote much of his time to the public good, Welch, like Dr. Johnson's Mead, has "lived more in the broad sunshine of life than any man." Many of the papers listed in this bibliography are described as "unpublished," which perhaps accounts for the appearance of the bibliography before the actual collected writings. Among, these, it is to be hoped that the many charming extempore talks at the Johns Hopkins Historical Club will be included. On such occasions, Welch, when the humor strikes him, improvises delightfully upon a set theme, like some genial musician of the past. The well-known "Ether Day Address" on "The Influence of Anæsthesia upon Medical Science" (1896) was written out without preparation in a railroad car, as he traveled to Boston, a fair example of his habit of improvisation. The two addresses on the evolution of scientific laboratories (1896) and the interdependence of medicine and science (1907), the latter also written out *en route* for Chicago, are perhaps the most interesting of Welch's contributions to medical history. Here, as everywhere, he has furnished young and old with food for thought, and often with new ideas. Dr. Burket is to be congratulated on the excellence and accuracy of his work, which follows the bibliographic norms set by the Surgeon General's Library. It is a most timely contribution. In the present emergencies, no man has labored more zealously and faithfully for the welfare of his country than William H. Welch.

F. H. GARRISON
ARMY MEDICAL MUSEUM

SPECIAL ARTICLES

WHAT SUBSTANCE IS THE SOURCE OF THE LIGHT IN THE FIREFLY?

IN at least three groups of luminous animals (fireflies, ostracod crustacea and mollusks),

two distinct chemical substances, besides water and oxygen, are necessary for light production. One of these is not destroyed by heat and is easily dialyzable; it can be prepared by extracting luminous animals with hot water. This substance has been termed *luciferin* by Dubois[1] and *photophelein* by myself.[2] The second substance is destroyed by heat and does not dialyze; it can be prepared by allowing a water extract of the luminous organ to stand until the light disappears. This has been called *luciferase* by Dubois[1] and *photogenin* by myself.[2] Whenever solutions (non-luminous) of these two substances are mixed, light immediately appears and is brighter the greater the concentration of the solutions.

According to Dubois, the thermolabile substance, luciferase (photogenin) is an oxidizing enzyme (hence the termination *ase*), which oxidizes the thermostable substance, luciferin (photophelein), which is therefore the source of the light. My own work has led me to belive that the thermolabile substance is not an enzyme, but is itself the source of the light and I have indicated this by calling it photogenin (phos, light; gennao, produce). The thermostable substance is, according to my view, a material which assists in the production of light and I have indicated this by calling it photophelein (phos, light; opheleo, assist).

Which is the source of the light, photogenin (luciferase) or photophelein (luciferin)? Fortunately the question can be answered by a simple crucial experiment. The two common eastern genera of fireflies produce light of different colors. *Photinus* emits an orange light, while *Photuris* emits a greenish yellow light. The difference in color is especially noticeable when the luminous organs of the two species are ground up in separate mortars. As shown by Coblentz,[3] the difference in color is real; the spectrum of *Photinus* extending further into the red than that of *Photuris*. The two light-producing substances can be prepared from each of the two species, and the photogenin of *Photinus* mixed with its own photophelein gives an orange light, while the photogenin of *Photuris* mixed with its own photophelein gives a greenish-yellow light, the color characteristic of the species. The two genera may also be "intercrossed" with respect to the two light-producing substances, *i. e.*, the photogenin of *Photinus* gives light with the photophelein of *Photuris* and vice versa. If the source of light is photophelein (luciferin) as Dubois believes, the light produced by *Photinus* photophelein (luciferin) × *Photuris* photogenin (luciferase) should be orange, the color characteristic of *Photinus*. I have found, on the contrary, that the light from this "cross" is greenish yellow. Conversely, the light from a mixture of *Photinus* photogenin (luciferase) and *Photuris* photophelein (luciferin) is orange. The color of the light in these "crosses" is that characteristic of the animal supplying photogenin (luciferase). The photogenin (luciferase) must, therefore, be the oxidizable substance and the source of the light.

How does photophelein assist in the production of light? The process is best studied in the marine ostracod crustacean, *Cypridina hilgendorfii*. The photogenin and photophelein of this animal are secreted into the sea water together, and in time the photophelein is used up and a perfectly clear colorless non-luminous solution of photogenin remains. If we add to such a concentrated solution, photophelein or certain specific substances in extracts of non-luminous forms, or fat solvents such as ether, chloroform and higher alcohols, or thymol, saponins, soaps, bile salts, or crystals of inorganic salts, such as NaCl, light appears. Many of these substances are not oxidizable (another proof of the inadequacy of Dubois's theory), but all of them are cytolytic agents. The cytolytic action of these substances on cells is the result of a dissolving action on the cell surface involving an increased dispersion of the colloids which results

[1] Dubois, R., *C. R. Soc. Biol.*, 1885, XXXVII., 559, and *Ann. de la Soc. Linn. de Lyons*, 1913, LX., and 1914, LXI., 161.

[2] Harvey, E. N., Science, N. S., 1916, XLIV., 652, and *Amer. Jour. Physiol.*, XLII., 318, 1917.

[3] Coblentz, W. W., Carnegie Inst. Wash. Pub. No. 164, 1912.

in the complete solution and dissolution of the cell. Photogenin is a colloid and I would suggest that these substances have a similar action on the colloidal particles of photogenin. We are not dealing here with a cytolysis of cell fragments present in the secretion, since these cytolytic agents (salts, thymol, etc.) cause light production even in solutions of photogenin filtered through porcelain or siliceous filters which remove all granules and cell fragments. I would suggest, therefore, as a working hypothesis rather than a formal theory, that photophelein acts by changing the aggregation state of the colloidal particles of photogenin toward that of greater dispersion, thus increasing the surface of the particles. It is known that oxidation occurs at the surface of many colloidal particles, and light production might easily result from auto-oxidation accompanying the dispersion of the colloidal particles.

Photopheleins from different species of animals have different chemical properties and, like the cytolysins, they are also specific to a considerable degree. Firefly photophelein will produce light on mixing with photogenin of other insects (*Pyrophorus*), but none or very faint light on mixing with photogenin from *Cypridina*. A non-luminous species of *Cypridina* contains a photophelein with marked light-producing action on the photogenin of the luminous *Cypridina*, but none with firefly photogenin. Photophelein, therefore, is to be compared with the specific cytolytic substances of blood sera, with this exception, that it is the photophelein of the same species which has the greatest light producing action whereas the blood of the foreign species is the one possessing the greatest cytolytic (hemolytic) power.

E. NEWTON HARVEY

PRINCETON UNIVERSITY

INOCULATIONS ON RIBES WITH CRONARTIUM RIBICOLA FISCHER[1]

THE white pine blister rust is established in the native white pine growth of many parts of New England. Since, in most sections of New England, the pine far outvalues the cultivated currants and gooseberries, the latter, together with the wild *Ribes*, are being removed to hold the disease under control. A cultivated currant or gooseberry, not susceptible to the disease and possessing commercial qualities, would be of much practical importance for future planting within the diseased area. Even a wild species of *Ribes* immune to the disease might be of value for breeding new resistant commercial varieties to replace those now being removed. For the purpose of discovering such resistant varieties or species of *Ribes*, inoculations under controlled conditions have been made during the past three years on 82 varieties of cultivated red, black and white currants, 23 varieties of cultivated gooseberries, and 48 species and hybrids of *Ribes* from various parts of the world. Field tests are also being made with many of the above varieties and species.

The varieties of a cultivated species show considerable variation in the degree of their susceptibility to the disease. The cultivated species of *Ribes* also vary decidedly in susceptibility. Some varieties and some species, notably *Ribes nigrum*, are very congenial hosts for the rust, very abundant uredinia and telia being produced thereon. In other varieties and species the rust spreads rapidly over the leaf surface and produces abundant uredinia, but the leaf tissue often dies before many telia are formed. In other cases a few uredinia form, at which time irregular areas of the leaf tissue die quickly, with or without further spread of the fungus around the dead area. Sometimes, instead of a definite area being killed, small streaks or flecks are killed. These dead spots often enlarge slowly, producing occasionally a few uredinia or telia. All intergradations are found between *R. nigrum*, upon which the maximum number of fruiting bodies form, and *R. leptanthum*, on which small dead areas and flecks are formed, on less than 10 per cent. of which rust spores are produced. The vigor of the plant and the age of the leaves have an influence on the development of the disease. The

[1] Published by permission of the Secretary of Agriculture.

size of the leaves has little influence, if they are relatively old, those less than one tenth normal size having taken the disease in a manner characteristic for the host species.

In many cases inoculations have been made with æciospores as well as with uredospores, similar results being obtained upon the same host. In most cases both uredinia and telia were produced. It has been impossible thus far to have all the species authoritatively identified, that being done as fast as the development of the plants will permit. Therefore this list is subject to such changes as further study of the plants may cause. The synonymy of the group is based, for the North American species, on Coville's treatment in "North American Flora," issued by the New York Botanical Garden, and for the species of the rest of the world on Janczewski's "Monographie des Grosseilliers, *Ribes* L." and supplements to that work.

Successful inoculations have been made upon the following species: *Ribes alpestre* Dec., *R. alpinum* L., *R. americanum* Mill., *R. aureum* Pursh, *R. bracteosum* Douglas, *R. carrierei* hybrid, *R. cereum* Douglas, *R. coloradense* Coville, *R. cruentum* Greene, *R. culverwellii* hybrid, *R. curvatum* Small, *R. cynosbati* L., *R. diacantha* Pallas, *R. divaricatum* Douglas, *R. erythrocarpum* Coville & Leiberg, *R. fasciculatum* Seib. & Zucc., *R. fontenayense* hybrid, *R. futurum* hybrid, *R. giraldii* Janczewski, *R. glandulosum* Grauer, *R. glutinosum* Bentham, *R. gordonianum* hybrid, *R. hesperium* McClatchie, *R. hirtellum* Michaux, *R. holosericeum* hybrid, *R. inebrians* Lindley, *R. inerme* Rydberg, *R. irriguum* Douglas, *R. lacustre* (Persoon) Poir., *R. leptanthum* Gray, *R. lobbii*, Gray, *R. menziesii* Pursh, *R. missouriense* Nuttall, *R. montigenum* McClatchie, *R. nevadense* Kellogg, *R. nigrum* L., *R. nigrum* var. *aconitifolium*, *R. odoratum* Wendl., *R. oxyacanthoides* L., *R. petraeum* Wulf., *R. reclinatum* L., *R. rotundifolium* Michaux, *R. sanguineum* Pursh, *R. setosum* Lindley, *R. speciosum* Pursh, *R. succirubrum* hybrid, *R. triste* Pallas, *R. viscosissimum* Pursh, *R. vulgare* Lam.

Successful inoculations have been made on numerous unidentified *Ribes* from all parts of the United States, including over one hundred collections made by R. K. Beattie in the Northwest and Pacific Coast States. Thus far no species has proved to be entirely resistant to the rust.

The writers acknowledge the aid of the following in carrying on these experiments and thank them for so kindly furthering the work: Mr. R. K. Beattie, Dr. G. R. Lyman, The Arnold Arboretum, The Forest Service and The Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, United States Department of Agriculture.

Perley Spaulding,
G. Flippo Gravatt

Office of Investigations in
Forest Pathology,
Bureau of Plant Industry,
Washington, D. C.

THE AMERICAN PHILOSOPHICAL SOCIETY. II

Naming American hybrid oaks: William Trelease, Sc.D., LL.D., professor of botany, University of Illinois, Urbana.

Thirty-eight known or probable hybrids among the oaks of the United States have been brought together from various and much scattered publications. No cases are believed to exist in which a species of the white oak group (*Leucobalanus*) has intercrossed with a species of the red oak group (*Erythrobalanus*). To the 38 accepted hybrids already recorded, two are added in this paper—× *Quercus palæolithicola* (a cross between *Q. ellipsoidalis* and *Q. velutina*), and *Q. Schuettei* (a cross between *Q. bicolor* and *Q. macrocarpa*). Of the 40 recognized hybrids, 15 have been given binomials by earlier writers: the remaining 25 are here named for the first time, in accordance with international rules of procedure.

The wild relatives of our cultivated plants and their possible utilization: W. T. Swingle, Ph.D., U. S. Department of Agriculture. (Introduced by Dr. William P. Wilson.)

An annotated translation of de Schweinitz's two papers on the rusts of North America: Joseph C. Arthur, professor emeritus of botany, Purdue University, Lafayette, Indiana, and G. R. Bisby. (Introduced by Professor John M. Coulter.)

The most illustrious botanist of the first half of the last century to give attention to fungous plants was L. D. von Schweinitz, of Salem, N. C., and later of Bethlehem, Pa. He became a member of the American Philosophical Society just one hundred years ago, and some time later published in the *Transactions* of the society the earliest list of "North American Fungi." This attempt at a comprehensive list for the whole country was not again made until the present time, but now the work is in progress, divided among a number of men. The rusts are being listed by Professor J. C. Arthur, LL.D., of Purdue University, Lafayette, Ind. He now presents to the society an estimate of von Schweinitz's notable achievement with this group of fungous plants. Of the four thousand species of fungi on Schweinitz's list 135 were rusts, a class of parasitic fungi of the greatest economic importance. All of Schweinitz's collection, now deposited at the Philadelphia Academy of Sciences, has been critically examined and identified, and a record made of the present knowledge relating to each form. Dr. Arthur pays a high tribute to the remarkable showing made by Schweinitz, to his great accuracy and industry, and to the eminent services which he rendered to American botany.

Ecology and physiology of the red mangrove: H. H. BOWMAN, fellow in botany, University of Pennsylvania. (Introduced by Professor Harshberger.)

The mangroves have been noted by the ancient Greeks in early classic literature. Nearchus, the admiral of Alexander the Great, mentioned them as being observed on Alexander's expedition into Asia. They were found by the Greeks growing along the shores of the Persian Gulf and the Red Sea. Theophrastus, the pupil of Aristotle, wrote concerning them as well as Pliny, and many medieval and later travelers and explorers. An examination has been made of the microscopic structure of the various tissues of these trees from material collected in the Gulf of Mexico, along the lower Florida Keys. Particular attention has been paid to the presence of intercellular stone cells and to the occurrence of tannin cells. The physiological relations of transpiration and absorption of these plants growing in sea water and all dilutions of it, as well as fresh water, have been studied, and the law deduced that the rate of transpiration varies directly with the concentration of the medium. Biochemically, it has been shown that there is a definite relation between the amounts of sugar and tannin in the hypocotyls at different stages of growth of the plants. Ecological factors show their effect on various tissues, particularly those of the leaves, *e. g.*, the variation in leaf thickness and structure in off-shore, in-shore, salt-water and fresh-water plants. Geologically, the mangroves are of importance in building up land and increasing the area of dry land on islands and continents in the tropics. Under economic considerations it may be stated that the tannin contained in the tissues is used for tanning leather. The wood is the source of an excellent charcoal, but chiefly the plants have been used in keeping up embankments along the seashores and in building dams and dykes. The distribution of these trees along the Florida peninsula and keys is plotted in a series of maps.

Reception from eight to eleven o'clock at the hall of the Historical Society of Pennsylvania, when George Ellery Hale, Ph.D., Sc.D., LL.D., F.R.S., director of the Solar Observatory of the Carnegie Institution of Washington, at Mt. Wilson, Calif., gave an illustrated lecture on "The work of the Mt. Wilson Observatory."

APRIL 14

William B. Scott, Sc.D., LL.D., Vice-president, in the chair

Biochemical studies of the pitcher liquid of Nepenthes: JOSEPH S. HEPBURN, M.S., Ph.D. (Introduced by Professor Harry F. Keller.)

The National Research Council and its opportunities in the field of chemistry: MARSTON T. BOGERT, Ph.B., LL.D., professor of organic chemistry, Columbia University.

The South American Indian in his relation to geographic environment: WILLIAM CURTIS FARABEE, A.M., Ph.D., curator of American Section of Museum, University of Pennsylvania. (Introduced by Mr. Henry G. Bryant.)

Interrelations of the fossil fuels: J. J. STEVENSON, Ph.D., LL.D., emeritus professor of geology, New York University.

This paper deals with the Cretaceous coals, which are vastly more important in the United States than in all the rest of the world. After description of stratigraphical and chemical conditions observed in the typical areas, an effort is made to present the characteristic features in such fashion that the relations to peat and the Tertiary coals may be made clear.

The distribution of land and water on the earth: HARRY FIELDING REID, Ph.D., professor of dynamic geology and geography, Johns Hopkins University.

Uplifted and dissected atolls in Fiji (illustrated): William Morris Davis, Ph.D., emeritus professor of geology, Harvard University.

In the southeastern part of the Fiji group a number of atolls uplifted several hundred feet above sea level, are now in various stages of dissection. In no case do they reveal a truncated volcanic platform; hence they discredit those theories of atoll formation which explain atolls or upgrowths of moderate thickness around the border of former volcanic islands that were reduced to submarine platforms by manual abrasion.

The slides on the Panama Canal: George W. Goethals, LL.D., Maj.-Gen. U. S. A., late chief engineer, Panama Canal.

Application of polarized light to study of ores and metals: Frederick E. Wright, Ph.D., of Geophysical Laboratory of Carnegie Institution of Washington.

In this paper the principles underlying the application of polarized light to the study of ores and metals are outlined. The possibilities and also the limitations of the different methods, new or old, now available, are indicated and the adaptation of these methods to metallographic and mineralographic work with the microscope is considered briefly.

Astrapotheria: William B. Scott, Sc.D., LL.D., professor of geology, Princeton University.

Diatryma, a gigantic Eocene Bird: William Diller Matthew, A.M., Ph.D., curator of vertebrate paleontology, American Museum of Natural History, New York. (Introduced by Professor W. B. Scott.)

The skeleton of a gigantic extinct bird was found last summer in the Bighorn basin of Wyoming by an expedition from the American Museum of Natural History. It is of Lower Eocene age, a contemporary of the little four-toed horse whose fossil remains are found in the same region. The bird was about as large as the extinct moas of New Zealand, much bulkier than any living bird, although not so tall as an ostrich. It stood nearly seven feet high. The head was enormous, eighteen inches long with huge compressed beak like the extinct *Phororhachos* of Patagonia, but unlike any living bird. The neck too was very massive and rather short, and it was quite unable to fly, the wings about as large as in the cassowary. Although it resembled the modern ostrich group in some ways, it was not related to them and only remotely related to any other known birds, the nearest perhaps being the *Seriema* of South America. A few fragments of this gigantic bird were found by the late Professor Cope over forty years ago, and named *Diatryma*, but it remained practically unknown until the discovery of this nearly complete skeleton. A description of this specimen by W. D. Matthew and Walter Granger, with photographs and a reconstruction, is now in press for the *Bulletin* of the American Museum.

AFTERNOON SESSION

William W. Keen, M.D., LL.D., President, in the chair

Presentation of a portrait of I. Minis Hays, M.D., dean of the Wistar Association: Joseph G. Rosengarten, LL.D., on behalf of the Wistar Association, on the Centennial Anniversary of its organization and in the twenty-first year of Dr. Hays's Secretaryship of the Society.

Symposium on Aeronautics—

Dynamical aspects: Arthur Gordon Webster, Ph.D., LL.D., member of Naval Advisory Board.

Physical aspects: Brigadier-General George O. Squier, Ph.D., chief of Signal Corps, U. S. Army. (Introduced by Dr. Keen.)

Mechanical aspects: William Frederick Durand, Ph.D., chairman of National Advisory Committee for Aeronautics. (Introduced by Dr. Walcott.)

Aerology in aid of aeronautics: W. R. Blair, Ph.D., assistant, United States Weather Bureau.

Discussion—

Mathematical aspects: Edwin Bidwell Wilson, Ph.D., professor of mathematics, Massachusetts Institute of Technology. (Introduced by Dr. E. W. Brown.)

Engineering aspects: Jerome C. Hunsaker, Eng.D., assistant naval constructor, U. S. Navy. (Introduced by Dr. Bauer.)

On Saturday evening the usual banquet was held at the Bellevue-Stratford, about sixty-five members and guests being present.

The following toasts were responded to:

"The memory of Franklin," by President Hibben, of Princeton.

"Our sister societies," by Wm. H. Welch, M.D., of Johns Hopkins.

"Our universities," by Professor T. F. Crane, of Cornell.

"The American Philosophical Society," by Mr. John Cadwalader, of Philadelphia.

Arthur W. Goodspeed,
Secretary